

Comment on “Extremely Low Frequency Magnetic Fields Can Either Increase or Decrease Analgesia in the Land Snail Depending on Field and Light Conditions” by Frank S. Prato, M. Kavaliers, and A.W. Thomas

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In their interesting work on the effects of ion resonance magnetic fields on snail opioid analgesia, Prato et al. [2000] state that there have been very few reports demonstrating that ELF magnetic field exposures “can have variable effects on a biological system depending on exposure parameters”. They also argue that their results provide a basis within the parametric resonance model (PRM) to help “understand how ELF effects can be of opposite sign”.

Both of these statements are questionable. Table 1 lists published reports in which not only significantly different results were observed in biological systems depending on ion cyclotron resonance (ICR) exposure parameters, but where these biological responses, depending on the ionic tuning, were each opposite in nature. We have not been reticent in pointing out this remarkable effect, at meetings and in our publications.

In each case listed in Table 1, an opposite response was obtained either by adjusting the DC field strength while maintaining the same AC frequency, or using two different frequencies while keeping the DC field fixed. Clearly, these results do not reflect changes in the strength of the AC field. In addition to the reports shown in Table 1, there have been at least two other reports presented as abstracts, which arrived at the same conclusion: one by Lovely et al. [1993], essentially anticipating the later publication by Zhadin et al. [1999] concerning the opposite learning response of rats and a recent study by Regling et al. [2002], replicating the earlier work by Smith et al. [1991] on chick embryonic femoral growth.

We also find fault with the conclusion that the “opposite” analgesiac responses observed for Ca^{2+} CR tuning and for K^{+} CR tuning provides evidence favoring the PRM. The one report quoted by Prato et al. [2000] in support of this argument was that by Ross [1990] in which two different AC intensities did indeed lead to an opposite change in cell proliferation. However, as was later shown by Jenrow et al. [1996], one has to be careful in distinguishing responses due to resonance interactions from those due to Faraday induction.

This does not mean that we find fault with the strength of the outstanding work accomplished by Prato’s group on providing experimental support for Lednev’s PRM. Rather we wish to emphasize that there are well-established results embodied in earlier cyclotron resonance experiments that are not explained by the PRM.

Despite our criticism, Prato et al. [2000] are correct in drawing attention to this interesting and still unexplained “opposite” effect that is unique to ICR studies. One cannot help, but compare the examples in physiology where bipolar metabolic regulation often follows hormonal mediation. We believe

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TABLE 1. Significantly Different Results Observed in Biological Systems Depending on ICR Exposure Parameters

Model system	Reference	Frequency (Hz)	DC field (μ T)	Ion	Response (relative to controls)
Diatom motility	Smith et al. [1987]	16	20.9	Ca^{2+}	Motility enhanced
		16	41.0	K^+	Motility inhibited
Embryonic bone	Smith et al. [1991] Regling et al. [2002]	16	20.9	Ca^{2+}	Bone growth enhanced
		16	40.7	K^+	Bone growth inhibited
Plant growth	Smith et al. [1993]	60	78.3	Ca^{2+}	Growth enhanced
		60	153.3	K^+	Growth inhibited
Rat behavior	Zhadin et al. [1999]	63	50	Mg^{2+}	Activity enhanced
		38	50	Ca^{2+}	Activity inhibited
Gravitropic response	Belova and Lednev [2000a]	35.8	46.5	Ca^{2+}	Gravitropy enhanced
		54.7	46.5	K^+	Gravitropy inhibited

this strikingly similar magnetic bipolar phenomenon speaks to an important, but as yet unresolved, clue regarding the nature of the ICR magnetic interaction.

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